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ABSTRACT

This study investigates the development of multiplicative classification skills in lower class black and middle class white children on tasks which contain either three-dimensional objects or two-dimensional pictorial representations of the same objects. Multiplicative classification refers to the simultaneous classification of objects into two or more categories. A total of 96 subjects were used, 32 from the following age levels: 4:0-4:11 years, 6:0-6:11 years, 8:0-8:11 years, each age group comprising half females and half males. One-half of the subjects (Ss) at each age level were lower class black children; the remainder were middle class white children. A matrix completion task was used. A subject is presented with stimulus objects in the form of a 2x2 matrix with one cell empty. A subject is to choose the object from a choice set that completes the matrix. Two practice matrices and five test matrices were employed. Familiar objects were used. Social class comparisons at each age level for the combined matrix forms indicated no significant difference at either the four-five or six-seven year levels. At the eight-nine year level lower class Ss performed significantly more poorly. There was a significant age by social class interaction effect. (JM)

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Social Class Differences and Task Variables in the Development of Multiplicative Classification

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The present study investigates the development of multiplicative classificatory skills in lower class black and middle class white children on tasks which contain either three-dimensional objects or two-dimensional pictorial representations of the same objects.

Multiplicative classification refers to the simultaneous classification of objects into two or more categories, e.g., a bat is both a flying animal and a mammal. Stated differently, multiplicative classification involves the ordering of objects at the intersection of two or more classes. Thus given the class of all mammals and all flying animals, the bat is an exemplar of the intersection of these classes.

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Within Piaget's theory (Flavell, 1963), the ability to grasp dual and multiple class membership is based upon the development of logical structures which become functional at approximately the sixth or seventh year of life. Specifically, it is based upon the logical grouping termed "bi-univocal multiplication of classes".

Multiplicative classification differs from what has traditionally been termed "free classification" in that it involves an understanding of logical relationships among two or more classes, specifically, a recognition of class intersection. In free classification, the child is required to construct

categories by grouping together all items which are "alike" or which "go together". Thus, he must determine the categories of classification himself, but once the categories are formed, he need not be concerned about their inter-relationships. In multiplicative classification, the categories of classification are given (e.g., within the structure of a matrix) and the child is required to make inferences about class relationships to determine the class intersect.

In several studies which focused on the problem of free classification, Sigel found that lower class children performed more poorly than middle class children when the stimulus material consisted of two-dimensional pictorial representations of objects rather than the actual three-dimensional objects (Sigel, Anderson, Shapiro, 1966; Sigel, McBane, 1967). Sigel attributes this difference to a deficiency in representational competence among lower class children.

The present study explores whether Sigel's findings generalize to multiplicative classification. This study also explores the performance of lower class black children and middle class white children on multiplicative classification at several age levels.

Method

Subjects. A total of 96 subjects were employed, 32 from the following age levels: 4:0-4:11 years, 6:0-6:11 years, 8:0-8:11 years. Males and females were evenly distributed within each group. One-half of the subjects at each age level were lower class black children drawn from an inner-city core area. Those at the 4-year level from this group were participants in the Early Push Programs; the older subjects attended public schools in this area. The other half of the subjects were middle class white children who attended nursery and elementary schools in a middle class section of the suburban

Buffalo area.

Procedure. A matrix completion task was employed for the assessment of multiplicative classification (Inhelder and Piaget, 1964). In this task, the S is presented with stimulus objects in the form of a 2 x 2 matrix with the bottom right cell being empty. The problem for the S is to choose the stimulus object from a choice set that completes the matrix, i.e., that simultaneously classifies the object as a member of both the class formed by the horizontal dimension and the class formed by the vertical dimension. The Raven Progressive Matrices are typical examples of this problem.

Two practice and five test matrices were employed. The matrix cells and choice cards were composed of familiar objects, e.g., crayons, spoons, forks, etc. Each matrix varied along three dimensions. The dimensions employed included size, color, number, and form. There were four choice cards for each matrix. Of these four cards, one correctly completed the matrix, one was totally redundant with one cell of the matrix, one was partially redundant with one cell of the matrix, and one was irrelevant to any of the matrix cells.

Two forms of each matrix cell and each choice card were constructed. One form consisted of the three-dimensional objects pasted on 4½" x 4½" pieces of heavy construction paper. The second form consisted of color photographs of the objects pasted on the same size construction paper. The photographs maintained size, color, and perspective relationships of the original objects.

Each S was tested individually on both forms of the matrices. Half of the Ss at each age and social class received the 5 object matrices, followed two days later by the 5 pictorial matrices. The other half of the Ss received the reverse order. Both order of presentation of the specific matrices and choices in the choice sets were randomized between and within Ss.

Results

a. No differences were found between the three-dimensional object form vs. the two-dimensional pictorial form of the matrices (Wilcoxin matched pairs test: Z = 1.92, $p > .05$), nor were differences found between pictures and objects at any other of the three age levels or between socio-economic groups at any age level. There were also no significant order effects for groups presented with pictures followed by objects vs. groups which received objects followed by pictures ($x^2 = .02$, df = 1, NS).

b. There was a significant increase with age in the number of correct solutions for combined picture and object matrices ($x^2 = 157.86$, df = 2, $p < .001$) and a significant age x social class interaction effect ($x^2 = 7.15$, df = 2, $p < .05$) for the combined data suggesting social class differences at specific age levels.

c. Social class comparisons at each age level for the combined matrix forms indicated no significant differences between social class at either the 4-5 or 6-7 year levels. However, there was a significant difference at the 8-9 year level indicating that the lower class Ss performed significantly more poorly than the middle class Ss ($x^2 = 17.57$, df = 1, $p < .001$).

d. Comparisons across age levels for each social class on the combined data indicated significant improvement between the 4-5 and 6-7 year level for both the middle class Ss ($x^2 = 39.70$, df = 1, $p < .001$) and the lower class Ss ($x^2 = 32.98$, df = 1, $p < .001$). Between the 6-7 and 8-9 year level, however, there was a significant improvement for the middle class group ($x^2 = 22.81$, df = 1, $p < .001$), but no differences were present for the lower class group ($x^2 = .80$, df = 1, $p > .30$). (see Table 1 and Figure 1).

e. Analyses of these results separately for the pictorial form and object form of the matrices contributed nothing new to these findings.

Conclusions and Implications

The absence of differences between picture and object forms of the matrix indicates that Sigel's findings for free classification do not generalize to multiplicative classification. One possible reason for this may reside in the differential employment of cues required in the matrix completion vs. free classification tasks. The matrix completion task is more highly structured in that the categories are already provided, giving the child a framework within which to make inferences about class relationships. It seems quite probable that fewer cues are required in this situation than in the free classification task where the child must construct his own categories on the basis of a disordered array of objects. Thus, we expect that two-dimensional objects provide sufficient cues for the inferences made in solving matrix completion problems, but that these cues are insufficient for free classification, and, in fact, require the enriched cues provided by three-dimensional objects. Further research will attempt to clarify these task differences.

In a study currently being conducted, the performance of lower class black and middle class white children ages 6-7 and 8-9 is being compared on matrix completion and spontaneous cross-classification tasks. These two forms of multiplicative classification vary in amount of structure inherent in the task, with apontaneous cross-classification being more similar to free classification in that the child must construct his own categories initially and then arrange them in the form of a matrix with recognition of class intersection. This study should provide additional insight into the kinds of operations utilized by children of differing social class in classifying according to matrix completion and free classification paradigms.

The positive findings of the study indicate that although both the middle

class and lower class children exhibit no differences in multiplicative classification at the 4-5 and 6-7 year levels, at the 8-9 year level the lower class group performs significantly more poorly than the middle class group. Furthermore, the lower class group exhibits no improvement in performance between the 6-7 and 8-9 year level.

An explanation of these findings requires that they be considered in the context of the normal stage development of logical structures. Within Piaget's system, the cognitive structures required for a logical mode of approach to problems of multiple classification as well as other types of classificatory and relational problems emerge at approximately the sixth or seventh year of life. Prior to this stage of concrete operations the child's approach to classificatory problems is generally characterized by an inability to systematically coordinate several stimulus categories and by a tendency to rely and act upon salient perceptual features of the task. The emergence of cognitive structures implies the development of the ability to coordinate categories but it does not imply that this change will immediately and universally be refleeted in performance. The problem of the reliance upon perceptual and possibly other task and situational features still remains. As Flavell and Wohlwill (1969) point out in their proposed elaboration and extension of Piaget's system, the transition period between pre-operations and concrete operations which extends from the point at which structures are "first-in-competence" up to the point that they are "always-in-perfommance" is a time when the child's behavior is most susceptible to task-related variables. From the point of view of the present discussion, this period is important because it represents a time during which the introduction of relevant task variables should lead to the activation of already present structures, and consequently, to an enhancement of performance which would be impossible prior to the emergence of cognitive

structures and meaningless once such structures are "always-in-performance".

The present senior author has provided some empirical support for this conceptualization of the activation of cognitive structures by demonstrating that reduction of the perceptual features in the matrix task results in significantly enhanced performance at the 6-7 year level whereas this variable is not effective at either the 4-5 year or the 8-9 year level (Overton & Brodzinsky, 1969).

Turning back to the results of the present study, these considerations of the transition between pre-operations and concrete operations form the basis for two alternative explanations of the poor performance of the lower class group at the 8-9 year level and of the failure of this group to exhibit improved performance between 6-7 and 8-9 years. First, both lower and middle class groups may develop the necessary cognitive structures simultaneously but activation may occur later for lower class children. This implies that, although the environment of the lower class child presents sufficient opportunities for the development of cognitive structures, it fails to provide, at the appropriate time, the relevant techniques necessary to orient him away from the perceptual world and toward reflective strategies. As a consequence, he remains locked into an earlier strategy at least until his ninth year. In an attempt to explore this hypothesis, we are currently conducting research on lower and middle class children which employs the activation techniques introduced by Overton and Brodzinsky.

The second alternative is that cognitive structures do not in fact develop simultaneously in both groups but rather that there is a retardation in the cognitive development of lower class children. As distinguished from the first alternative, this explanation implies that the environment does not provide the lower class child with sufficient opportunities for the normal rate of

structural development. Experimentally, the retardation of the emergence of cognitive structures in the lower class child would mean that activation techniques would be ineffective in enhancing performance over longer developmental time spans for these children than would be the case with the middle class children. Thus, for example, while activation techniques are not successful at the 4-5 year level, but are effective at 6-7 years for middle class children, such techniques would not result, according to this interpretation, in enhanced performance for lower class children until possible 8-9 or 10-11 years.

Regardless of whether one or the other or even possibly a combination of these two alternative explanations receives empirical support from further research, it should be noted that a focus on techniques which activate available cognitive structures, as distinguished from conditions which lead to the development of these structures, provides an important approach to the assessment of individual differences in cognitive development. It should also be recognized that determination of whether a specific task or situational variable is an activation variable does not depend merely upon whether its introduction enhances performance. Rather, it requires evidence that the variable enhances performance following and prior to periods of no effect, i.e., following the period of structures "not-in-competence" and prior to the period of structures "always-in-performance."

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Table 1

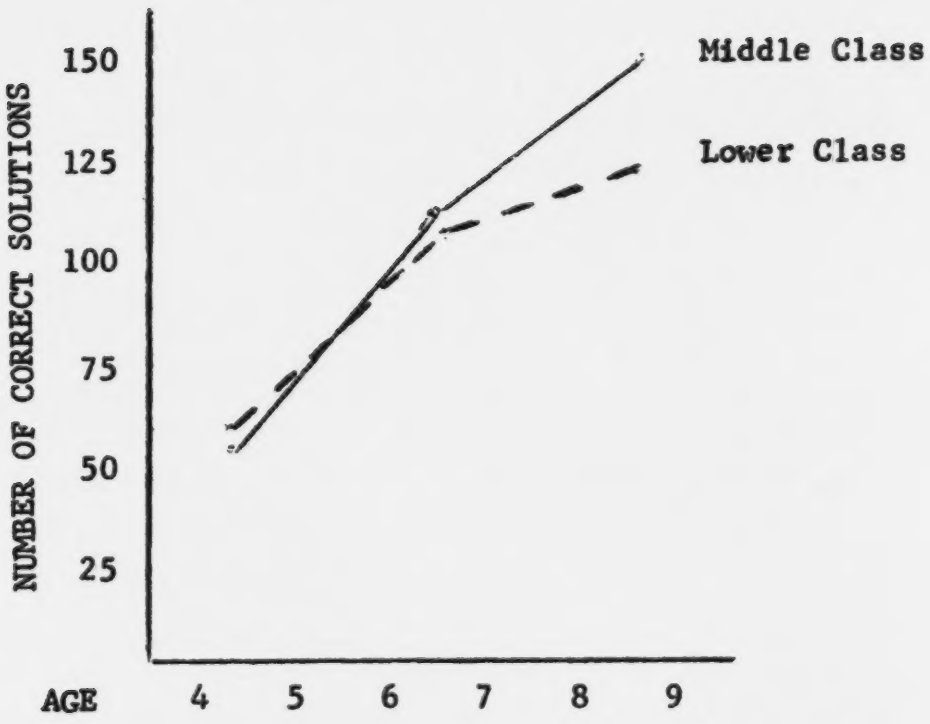
FREQUENCY DISTRIBUTION FOR CORRECT CHOICES
(OBJECT AND PICTURE FORMS COMBINED)

AGE	4		6		8	
	M-C	L-C	M-C	L-C	M-C	L-C
correct solution	61	64	117	115	149	122
incorrect solution	99	96	43	45	11	38

M-C = middle class

L-C = lower class

Figure 1



NUMBER OF CORRECT SOLUTIONS AS FUNCTION OF AGE AND SOCIAL CLASS